

AL/HR-TP-1995-0013



**APPLICATION OF THE TRAINING EFFICIENCY AND
EFFECTIVENESS METHODOLOGY (TEEM) TO AEROSPACE
GROUND EQUIPMENT TECHNICAL TRAINING**

Mark S. Teachout

**HUMAN RESOURCES DIRECTORATE
TECHNICAL TRAINING RESEARCH DIVISION
7909 Lindbergh Drive
Brooks AFB, Texas 78235-5352**

Douglas J. Sego

**DEPARTMENT OF MANAGEMENT OF ORGANIZATIONS
HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY
Clear Water Bay, Kowloon, Hong Kong**

J. Kevin Ford

**PSYCHOLOGY DEPARTMENT
MICHIGAN STATE UNIVERSITY
Psychology Research Building
East Lansing, Michigan 48824-1117**

19960130 039

June 1995

Final Technical Paper for the Period August 1992 - December 1993

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**ARMSTRONG
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MARK S. TEACHOUT, Ph.D.
Senior Scientist
Technical Training Research Division


R. BRUCE GOULD, Ph.D.
Technical Director
Technical Training Research Division


JAMES BUSHMAN, Lt Col, USAF
Chief, Technical Training Research Division

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE April 1995		3. REPORT TYPE AND DATES COVERED Interim August 1992 - December 1993	
4. TITLE AND SUBTITLE Application of the Training Efficiency and Effectiveness Methodology (TEEM) to Aerospace Ground Equipment Technical Training				5. FUNDING NUMBERS PE - 62205F PR - 1121 TA - 12 WU - 00	
6. AUTHOR(S) Mark S. Teachout Douglas J. Sego J. Kevin Ford					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Armstrong Laboratory Human Resources Directorate Technical Training Research Division 7909 Lindbergh Drive Brooks Air Force Base, TX 78235-5352				8. PERFORMING ORGANIZATION AL/HR-TP-1995-0013	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSORING/MONITORING	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release: distribution is unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This report documents the initial application of the Training Efficiency and Effectiveness Methodology (TEEM). Efficiency and effectiveness data were collected, summarized and displayed for the Aerospace Ground Equipment Airmen Basic Residence course. The results demonstrate how this methodology can be used by course personnel to re-assess training needs and re-design the course. Future directions for this methodology are described, including the incorporation of training transfer data and the development of IBM compatible software.					
14. SUBJECT TERMS Training Evaluation Training Effectiveness Training Efficiency Matching Technique				15. NUMBER OF PAGES 13	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UNCLASSIFIED		

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PREFACE

This report documents the results of a preliminary study conducted to demonstrate the viability of the Training Efficiency and Effectiveness Methodology (TEEM). This work was performed under in-house Work Unit No. 1121-12-00.

The authors are grateful to Major Marty Pellum, Capt Mary Knoll and Ms. Michele Morales Olea for their contributions at earlier stages of this project. A previous version of this paper was presented at the annual meeting of the International Military Testing Association, October, 1993.

APPLICATION OF THE TRAINING EFFICIENCY AND EFFECTIVENESS METHODOLOGY (TEEM) TO AEROSPACE GROUND EQUIPMENT TECHNICAL TRAINING

SUMMARY

The Training Efficiency and Effectiveness Methodology (TEEM) was demonstrated in this initial application to the Aerospace Ground Equipment technical training course. Course efficiency and effectiveness information were collected, summarized and displayed to demonstrate how these data could be used by course personnel to re-assess training needs and re-design the course.

I. INTRODUCTION

A significant amount of resources are devoted to initial technical training in the military. Therefore, training that is irrelevant or inappropriate for technical training is inefficient and costly (Ruck, Thompson, & Stacy, 1987). Due to the reduction of resources devoted to training and the increased complexity of Air Force equipment and jobs, improving the quality of training has never been more critical. The purpose of this paper is to describe an initial research and development effort directed at assessing the efficiency and effectiveness of Air Force training courses for the purpose of training course re-design. We call this new approach the Training Efficiency and Effectiveness Methodology (TEEM).

Background

There are multiple purposes and reasons for evaluating training. The most popular framework for depicting the training evaluation process was developed by Kirkpatrick (1976). This four-level framework includes: student reactions to training; learning of facts, principles or techniques; changes in on-the-job behavior; and tangible business results. Although this framework has advanced the practice of training evaluation over the years, there is no specific mechanism offered for using the evaluation information to make changes to training courses.

However, training models, such as those proposed by Goldstein (1991) and the Instructional Systems Design (ISD) process used by the Air Force (AF Manual 50-2, 1979), depict evaluation as a key component that provides feedback information to the needs assessment, design, development and delivery stages of training to continuously update and improve the entire training process. In most cases, training evaluation information is used to determine if a course worked or not (e.g., Kirkpatrick's criteria), and whether individual students passed or failed the course. These training models suggest a more important role for evaluation information. Evaluation information should be instrumental in helping training managers, course designers, developers and instructors make informed, accurate and meaningful changes to the course.

Despite these conceptual models, little research has been conducted to develop methodologies for using training evaluation information to make training course changes. One exception is Ford & Wroten (1984), who developed a Matching Technique that compares, or matches, the importance of a task to job performance (i.e., recommended "training emphasis") to the emphasis placed on tasks in a training program in order to depict the content validity of

training. Ford & Sego (1990) recommended that this technique be used to determine training efficiency and developed a conceptual framework to integrate efficiency and effectiveness information for course re-design. The present paper describes the initial effort to demonstrate the potential use of this methodology.

II. METHOD, PROCEDURE AND RESULTS

Participants

Participants were 182 Aerospace Ground Equipment (AGE) trainees in the Airman Basic-in-Residence (ABR) course at Chanute AFB, IL. In addition, the training manager, course developers and instructors participated in various stages of the data collection process. The course consisted of 14 blocks of instruction taking 18 weeks.

Training Efficiency

Training efficiency examines whether the appropriate amount of time is devoted to each task taught in training. This requires information that "recommends" the time required to learn a task and the actual time devoted to training each task. Occupational Survey Reports (OSRs) produced by the Air Force's Occupational Measurement Squadron (OMS) contain a rich source of information that is used to identify and prioritize tasks to be included in initial technical training courses. From the OSR, the task learning difficulty rating was used as the measure of the recommended time to learn a task. Since this index is based on the notion of task learning time, it provides a reasonable estimate of the relative time that should be devoted to training each task. The construct validity of the task learning difficulty ratings have been well established against entry-level training variables (Mumford, Weeks, Harding, & Fleishman, 1987) and job performance measures (Dickinson & Teachout, 1993).

A four-step procedure was developed to collect information on the actual time (in hours) devoted to each task taught in training. First, course personnel determined which OSR tasks were taught in the course. One-hundred and fifty-two of the 1016 total tasks were taught in the ABR course. The second step required instructors to link these 152 tasks to specific training objectives in the course Plan of Instruction (POI). In several cases, a single task was covered in more than one training objective. The third step required instructors to divide the time allocated for each training objective among all of the tasks covered in the objective. For example, if an objective contains 6 hours of instruction and 3 tasks are covered in that objective, the instructors estimated how much of the 6 hours was spent on instruction for each task. The fourth step was to sum the amount of training time devoted to each task. Since tasks could be covered by more than one training objective, the time for each task was summed to create a single number for the amount of time spent training that task in the entire course.

Before the task learning difficulty rating and the hours spent in training could be matched for each task, both variables were transformed into standard scores with a mean of zero and a standard deviation of one. Ford and Wroten's (1984) Matching Technique was then used to "match" the two data elements and the results were plotted for each task.

For demonstration purposes, Figure 1 displays the results of these matches for 10 tasks. These tasks were chosen to represent different content areas (i.e., AGE equipment) and different levels of task learning difficulty. The task learning difficulty rating (i.e., relative time to learn) is represented on the x-axis, the actual course time spent training each task is represented on the y-axis, and the resulting match is represented in the figure by the OSR task numbers. Three potential outcomes are depicted. Training matches result when the difference between the two variables is small (i.e., the standard score difference is 1 standard deviation or less). Thus, these task numbers are displayed between the diagonal lines on the graph. When the task learning difficulty variable is greater than the corresponding actual training time variable (i.e., the task learning difficulty standard score exceeds the actual task time standard score by more than 1 standard deviation), the task number falls in the bottom-right of the graph, indicating a potentially under-trained task. Alternatively, when relatively more time is spent training a task, compared to the corresponding task learning difficulty variable (i.e., the actual training time standard score exceeds the corresponding task learning difficulty standard score by more than 1 standard deviation), the OSR task number is displayed in the upper-left of the graph, indicating a potentially over-trained task.

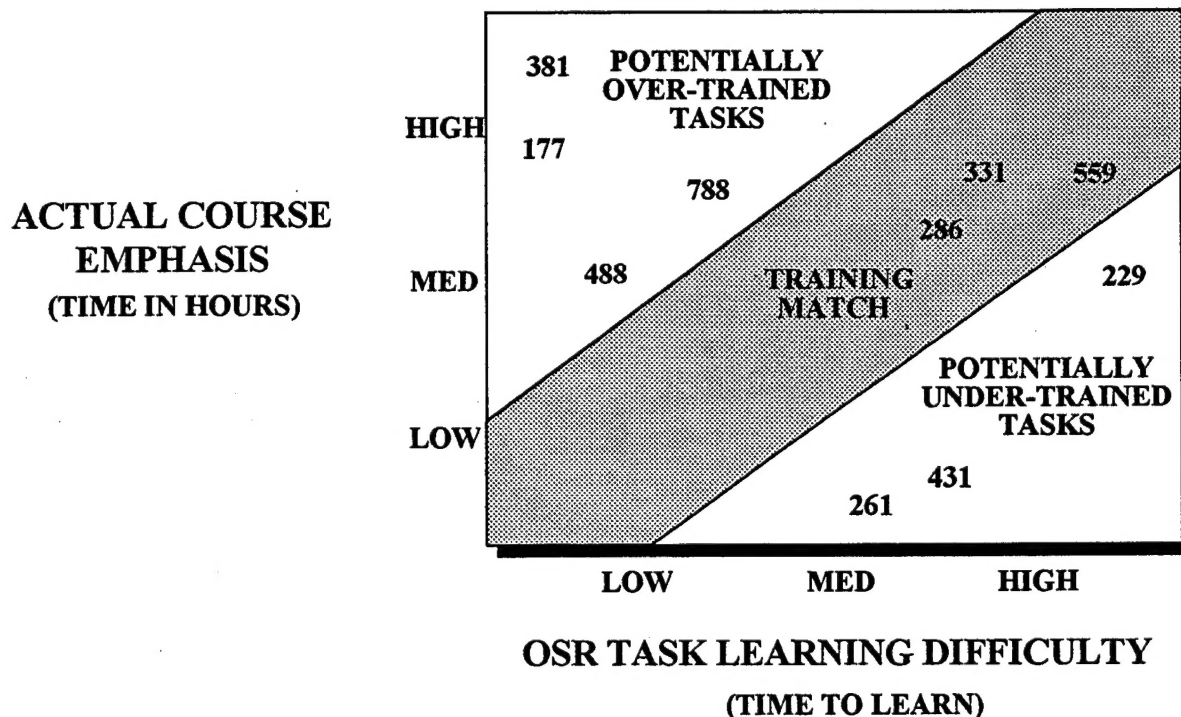


Figure 1. Matching Technique to Assess Training Efficiency.

Results were found for each of the three potential outcomes. For example, Task 559, Test Cylinder Compression, is a match, indicating that the relative amount of time spent in training seems appropriate. However, Task 381, Isolate Electrical Circuitry Malfunctions, is potentially over-trained task, while Task 261, Perform Generator Service Inspections, is a potentially under-trained task.

Training Effectiveness

Training effectiveness determines whether trainees learned or can perform the tasks taught in training. This requires information about the knowledge or performance levels of trainees at the end of the training program and later on the job. The greater the learning and performance, compared to a specified standard, the greater the effectiveness of the training program. In this study, training effectiveness was examined for knowledge, only at the end of the training program.

An end of course knowledge test was developed to determine whether trainees learned the material that was taught in training. Between 6 and 12 multiple-choice test items were developed for the each of the 10 tasks referred to above. This test was administered to 152 trainees after they completed the ABR course. These knowledge test scores were used as the effectiveness measure. A 70% criterion was used for the knowledge items associated with each task. For this study, knowledge level was dichotomized as low (i.e., below standard) or high (i.e., above standard).

Figure 2 displays the efficiency and effectiveness integration as a 3 X 2 matrix. Overall, when performance is above standard, it is less likely that course revisions are necessary. Using the previous examples, Task 559 is a Training Match that graduates learned above standard. However, Task 381 is a potentially Over-Trained Task that graduates learned above standard. This is a potential area where training time could be reduced if the course was shortened or if additional time is required in another area of the course. On the other hand, course revisions are more likely, if not required, whenever performance is below standard. Again, using the previous example, Task 261, is a potentially Under-Trained Task, that graduates learned below standard. A potential revision here might be to add training time to this area. Of course, other options should always be considered, such as developing improved instructional approaches.

		KNOWLEDGE LEVEL	
		LOW (BELOW-STANDARD)	HIGH (ABOVE-STANDARD)
RESULTS OF MATCHING TECHNIQUE	POTENTIALLY OVER-TRAINED TASKS	488 788	177 381
	TRAINING MATCH		559 331 286
	POTENTIALLY UNDER-TRAINED TASKS	431 261	229

Figure 2. Training Efficiency and Effectiveness Integration.

III. DISCUSSION AND SUMMARY

This paper demonstrated the potential use of the TEEM for training program re-design. In general, the results illustrate how training time might be reduced for over-trained tasks that were performed well, while training time might be increased for under-trained tasks that were performed poorly. Thus, this information might be utilized to facilitate training course changes. In the Air Force, training personnel frequently make training course revisions due to reductions in course length, additional requirements dictated by policy changes, or customer feedback that suggests that an area of training is deficient. This methodology utilizes relevant information, integrates that information in a way that is easy to use and understand, and puts it in a format that can facilitate decision-making by training course personnel.

Only 10 tasks were displayed here for demonstration purposes. For the course personnel, the Matching Technique was used to display results for the tasks associated with each block of instruction. Thus, all 152 tasks in the course were matched and graphed. Although some potential benefits of integrating key evaluation information was demonstrated, it is too time consuming and obtrusive to develop and administer multiple knowledge test items that tap individual task knowledge. In addition, since all trainees must meet the knowledge and performance standards to complete training, it is unlikely that task-level effectiveness information in the course is worthwhile. All tasks would fall in the "above standard" column of the

would provide any added value, since all tasks would fall in the "above standard" column of the effectiveness and efficiency integration. Therefore, in future applications we will focus on job effectiveness information from supervisory performance ratings. This provides feedback directly from the field personnel that utilize the course graduates and there is likely to be some tasks that fall below the trained standard.

We also plan to collect data from graduates on early on-the-job opportunities to perform (OTP) trained tasks (Ford, Quinones, Sego, & Sorra, 1992). By examining when graduates first begin performing the trained tasks, along with the amount and type of practice they receive, training transfer can be assessed and used to facilitate changes to training courses. For example, if there is considerable time devoted to training a task, yet relatively few graduates report actually performing the task in their first year on the job, training personnel might consider reducing the time spent training that task and allocate that time to other tasks in the course. Finally, efforts are in progress to develop IBM compatible software that will read in data, integrate, display and print the results such as those presented in this paper.

In summary, this methodology is a simple, rational approach that facilitates training course revisions by linking training content, training efficiency and training effectiveness information in a format that is easy to use and understand, and importantly, will facilitate decision-making by training course personnel. Conceptual models of training (e.g., Goldstein, 1991) suggest that evaluation plays a vital role in helping training personnel re-assess training needs and re-allocate training resources. This methodology helps us take a step in that direction.

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